Federal Aviation Administration's Evaluation of Loran-C I-CNS Conference Briefing

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Purpose of Evaluation

- To ***assess*** whether Loran-C can provide the:
  - Accuracy
  - Availability
  - Integrity
  - Continuity, and
  - Coverage

  to support Lateral Navigation through all phases of flight
- To ***assess*** what other ancillary benefits can be derived from the continued provision of Loran-C services, e.g.,
  - An alternate/robust/backup means of transmitting WAAS corrections to aircraft and other transportation modes
  - A Stratum I timing source to serve as an alternate/robust/ backup in case GPS/WAAS timing becomes unavailable

Current US Loran-C Policy

"While the Administration continues to evaluate the long-term need for continuation of the Loran-C radionavigation system, the Government will operate the Loran-C system in the short term. The U.S. Government will give users reasonable notice if it concludes that Loran-C is not needed or is not cost effective, so that users will have the opportunity to transition to alternative navigation aids. With this continued sustainment of the Loran-C service, users will be able to realize additional benefits. Improvement of GPS time synchronization of the Loran-C chains and the use of digital receivers may support improved accuracy and coverage of the service. Loran-C will continue to provide a supplemental means of navigation. Current Loran-C receivers do not support nonprecision instrument approach operations."

- ***Para 3.2.5 B 1999/2000 US Federal Radionavigation Plan***

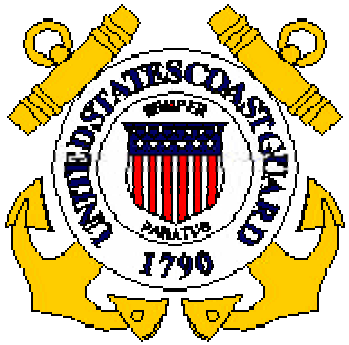
Volpe GPS Vulnerability Study

- Recognized the potential for Loran-C to be a robust backup system for:
  - GPS navigation
  - GPS augmentation, and
  - Timing
    - Cellular telephone networks
    - Other applications requiring/benefiting from Stratum I timing
- Made specific recommendations regarding Loran

Volpe Recommendations

- "In an effort to provide the greatest benefit to the users, encourage the development of affordable vehicle-based backups such as GPS/inertial receivers, and, in the event Loran-C becomes a viable terrestrial backups to GPS, aviation certifiable Loran-C receivers, and GPS/Loran-C receivers."
- "Conduct a comprehensive analysis of GPS backup navigation and precise timing options including VOR/DME, ILS, Loran-C, inertial navigation systems, and operating systems."
- "Continue the Loran-C modernization program of the FAA and USCG, until it is determined whether Loran-C has a role as a GPS backup system. If it is determined that Loran-C has a role in the future navigation mix, DOT should promptly announce this to encourage the electronics manufacturing community to develop new Loran-C technologies."

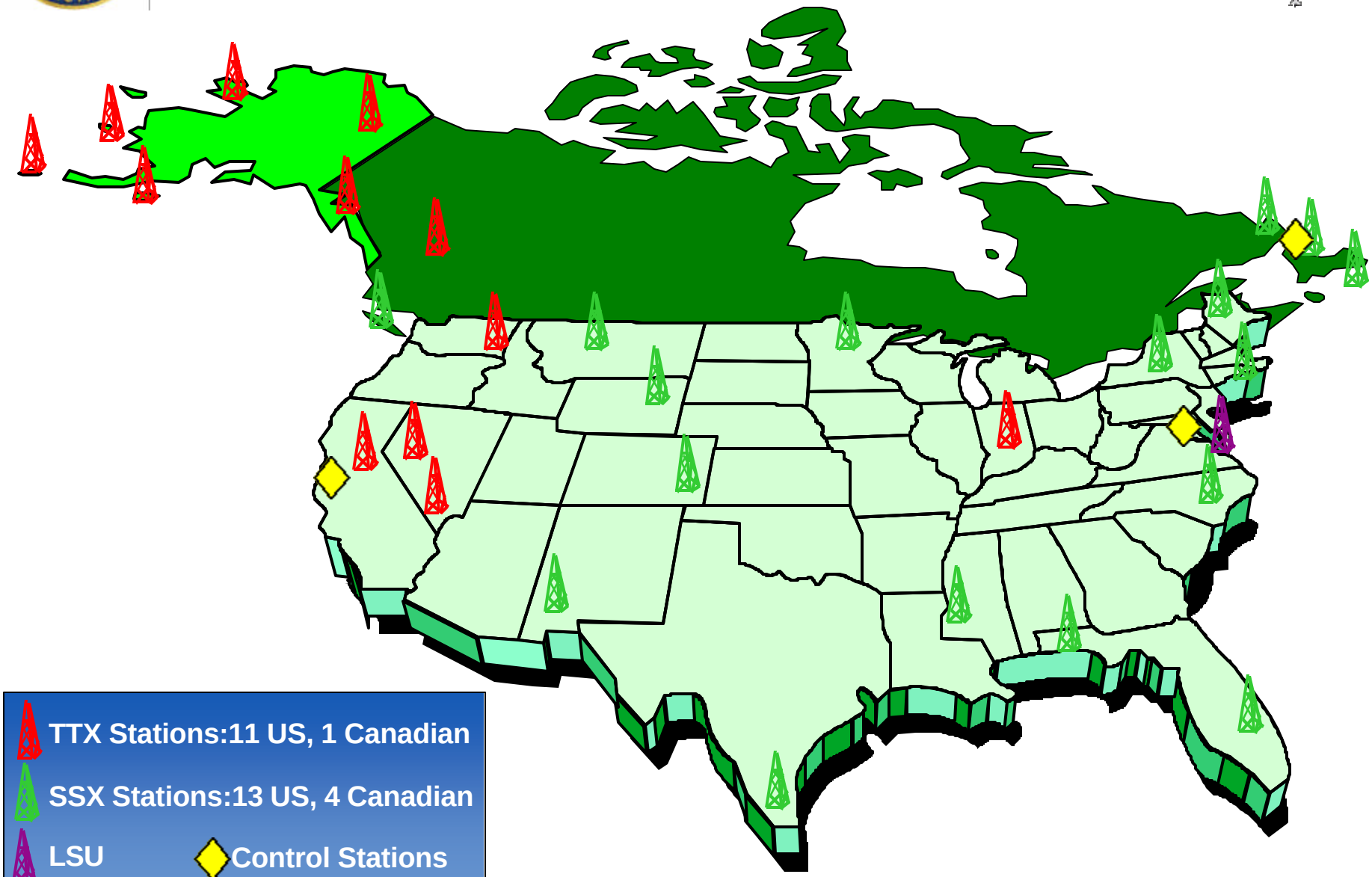
Program Logo Collection



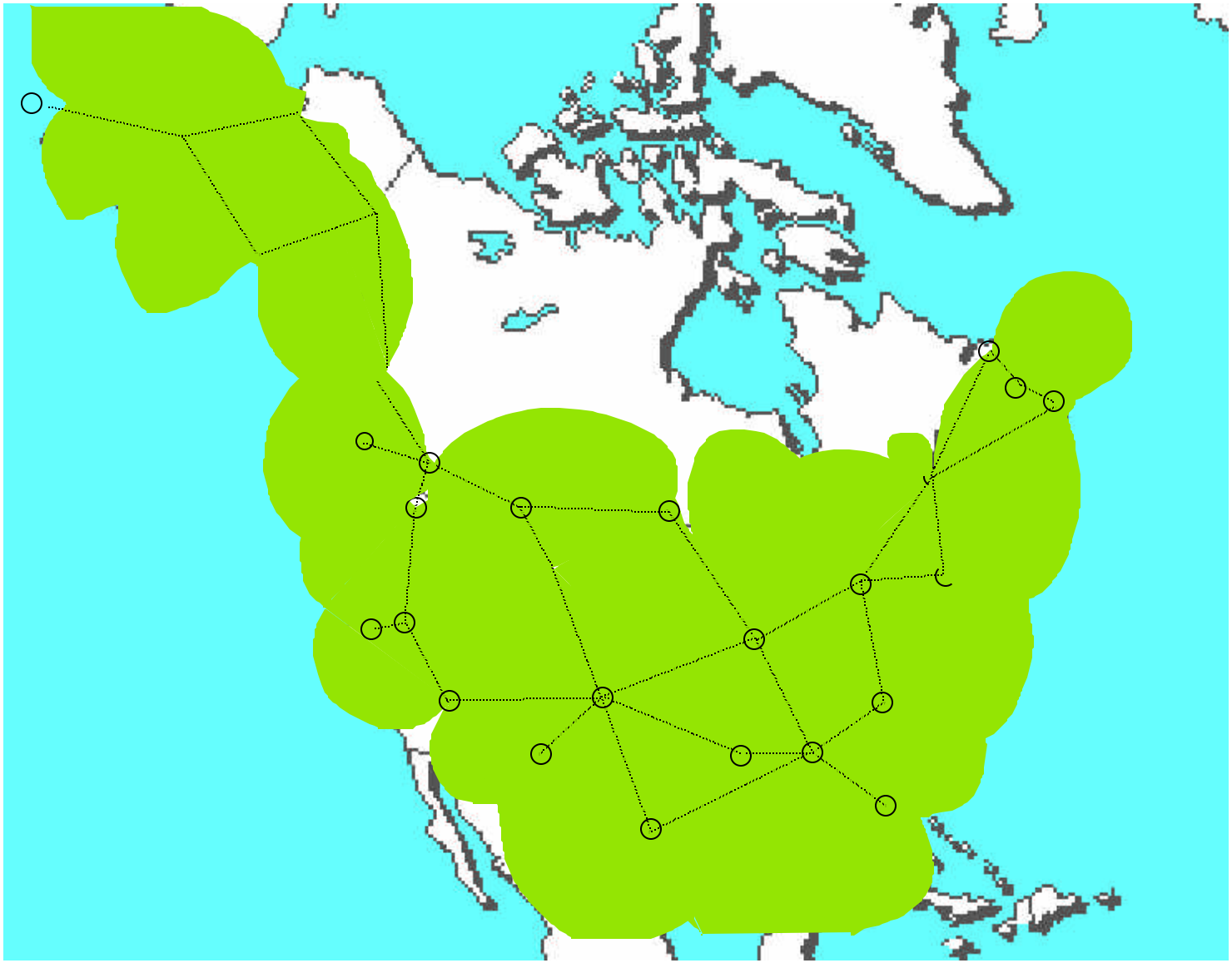
Loran-C Today

- Loran-C is a true, independent, radionavigation system operating 90kHz – 110 kHz
  - i.e., it is not an augmentation of another system
- It may be used as a supplemental navigation source in both en-route and terminal airspace under both visual flight rules (VFR) and instrument flight rules (IFR).
- No Loran-C approach procedures currently exist in the National Airspace System (NAS).

Loran-C Today (2)



Loran-C Navigation Coverage



Loran Issues

Issues	Potential Mitigations
Availability	
Precipitation Static	H-Field Antenna
Loss of Station Power	UPS
Lightning	New Lightning Protection
Chain Availability	All-in-view receivers
Tube overloads	Solid-state transmitters
Accuracy	
Old timing sources	New cesium clocks
Old timing equipment	New timing suite
Tube technology	Solid-state technology
Old ASF Corrections	New ASF tables/algorithms

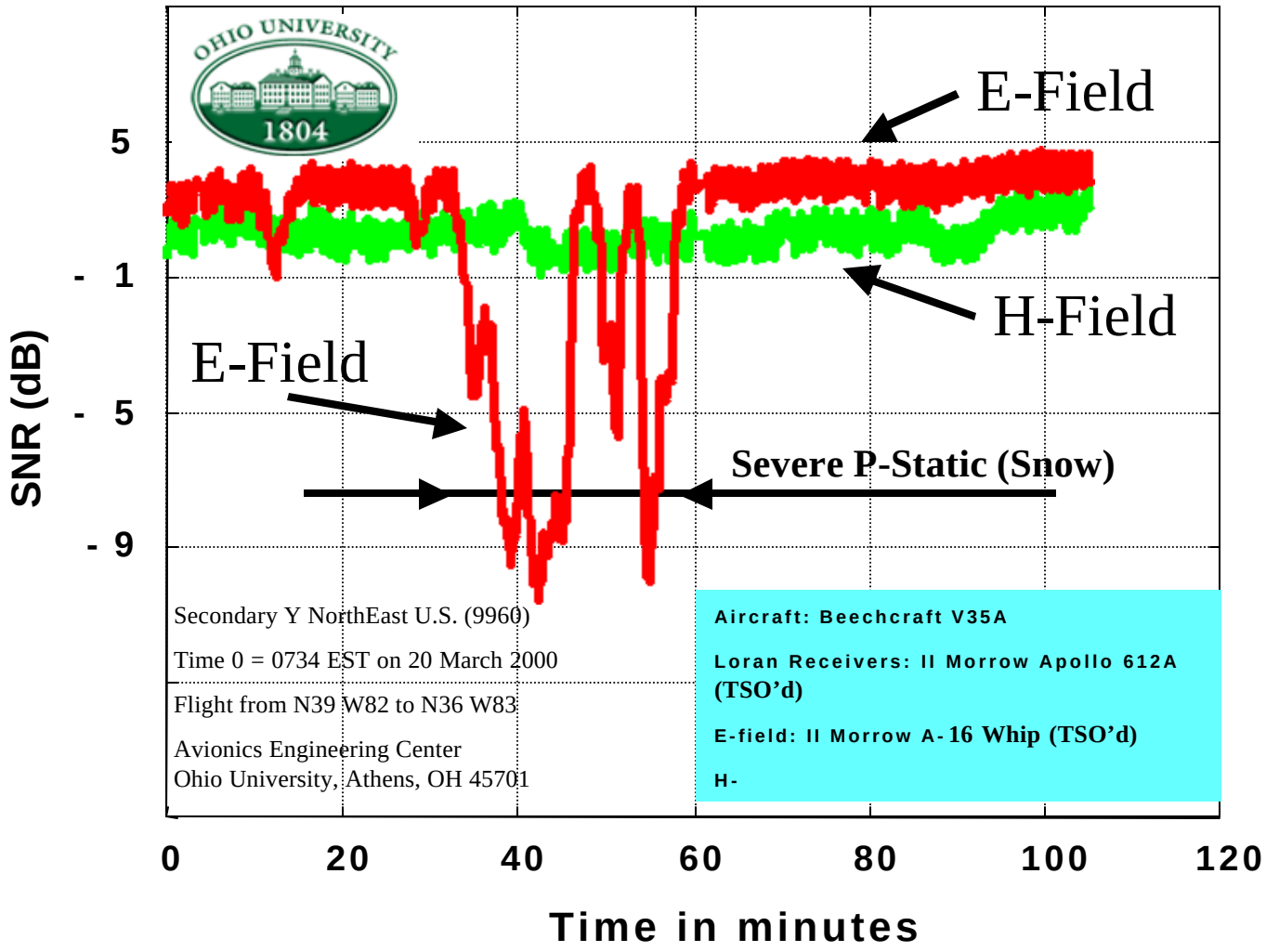
Loran Issues (2)

Issues	Potential Mitigations
Integrity	
Manual System	Automatic Blink System (ABS)
Presumed Integrity	Loran Integrity Panel
Continuity	
Triad-based approaches	All-in-view navigation
Receiver acquisition time	New DSP technology
Coverage	
Lack of navigation coverage on Alaskan North slope and Southern Florida	Additional Loran stations (?)

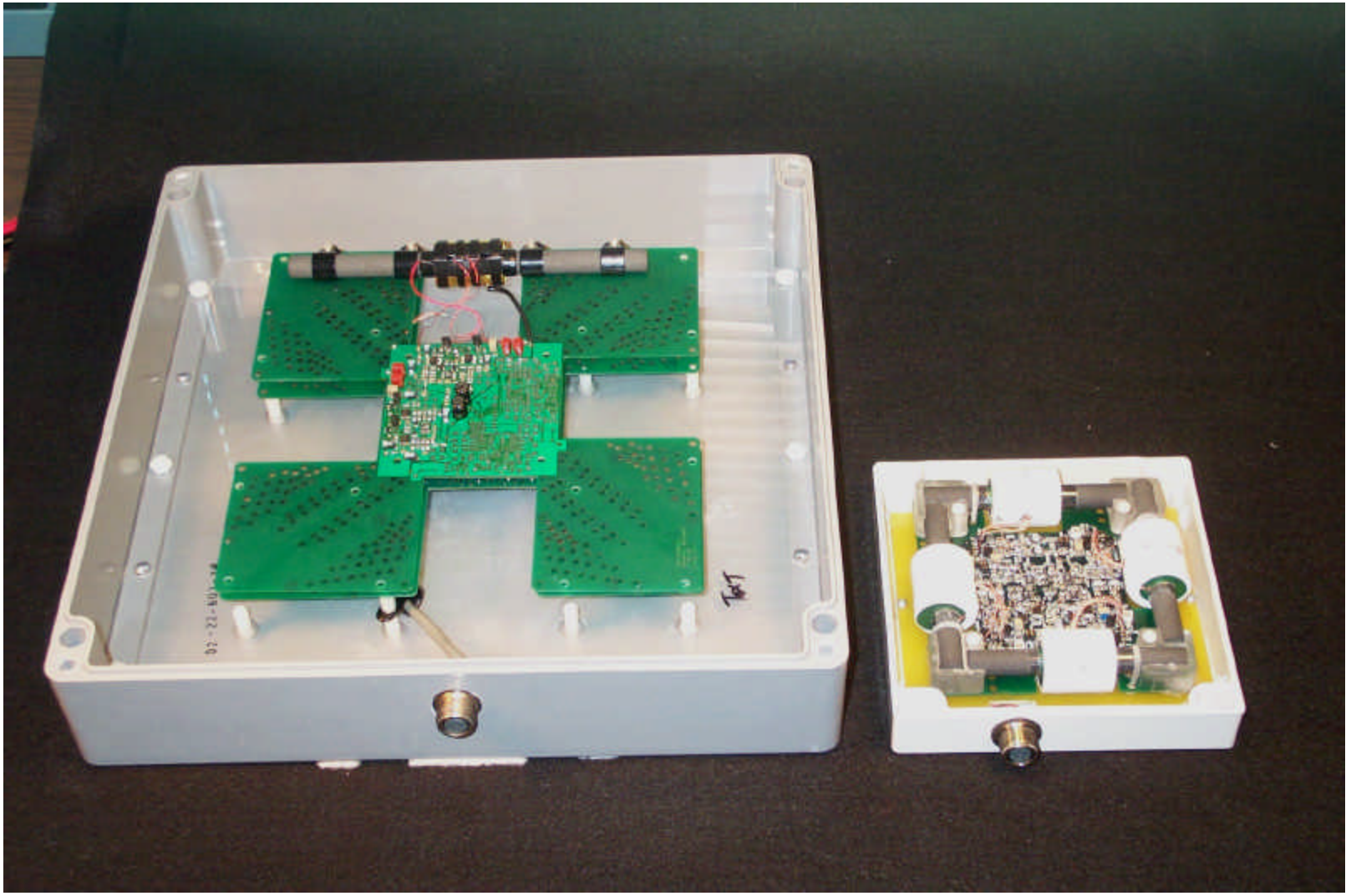
Status of FY 2001 Activities

- Developed and tested H-Field antennas
  - Locus, Inc.
  - Megapulse, Inc.
- FAATC, USCG Academy, and Ohio University tested all-in-view DSP receivers and H-Field antennas
  - Initial flight testing conducted by US Coast Guard Academy and Ohio University during May 2001 flights based out of Westerly, RI
  - Additional flight testing conducted in June 2001 based out of FAA Technical Center

E-Field - H-Field Comparison



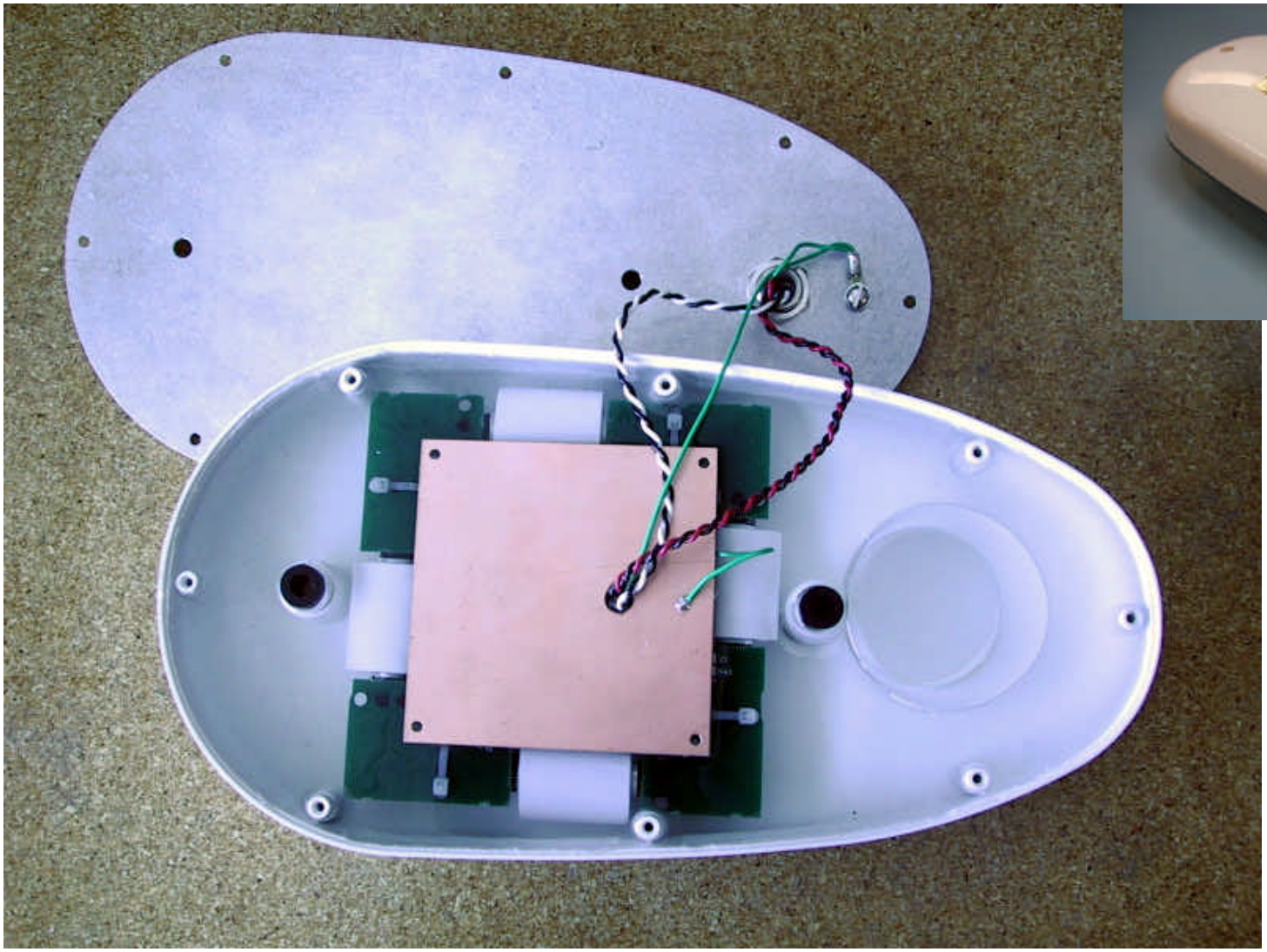
Antenna Efforts (Con't)



Phase I Antenna

Phase II Antenna

Antenna Efforts (Con't)

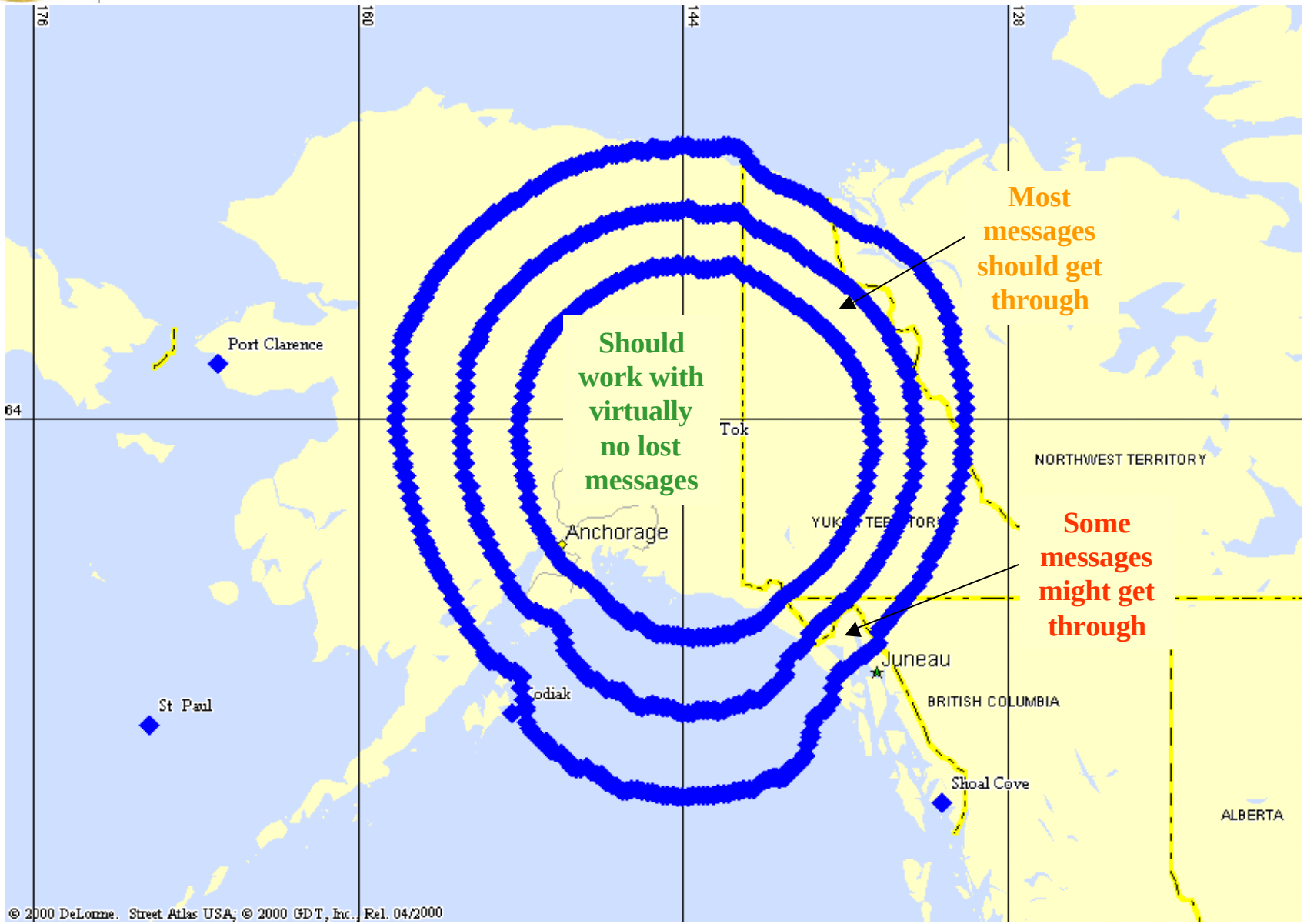


H-Field Antenna Mounted in Bendix-King ADF Radome

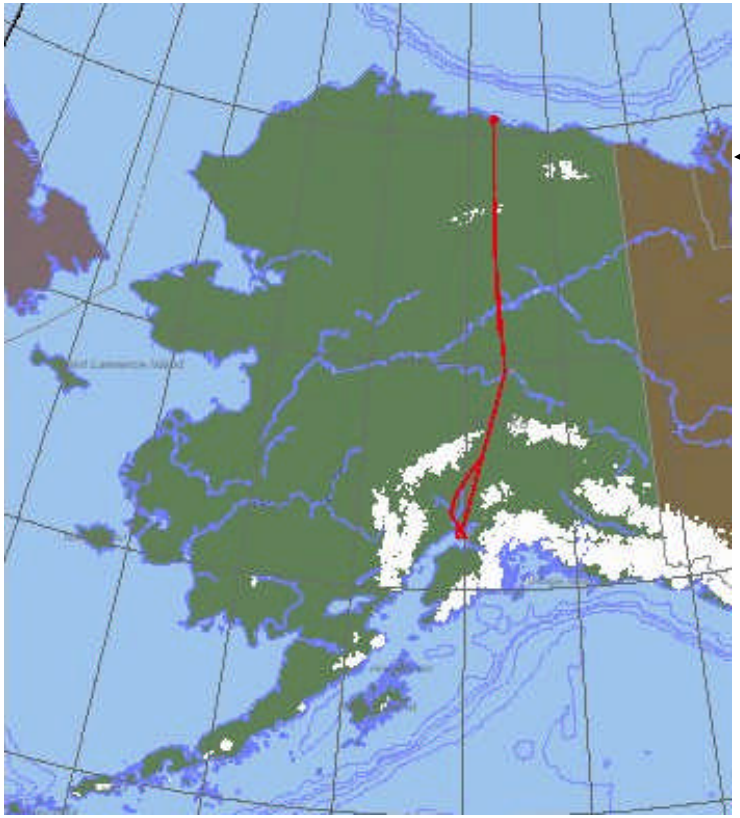
Alaska Loran Study/LOGIC Tests

- Alaskan NAS Evaluation Conducted August 21 – 25
  - Test of all-in-view (AIV) receivers and LOGIC
    - Two aircraft:
      - FAATC Convair 580
      - Ohio University King Air
    - Determine availability of WAAS signal via Geo (W_G)
    - Determine capability and coverage of one Loran station (i.e., Tok) to broadcast WAAS message to aircraft (W_L)
    - Determine ability to provide LNAV navigation to aircraft

Predicted Tok Loran Coverage

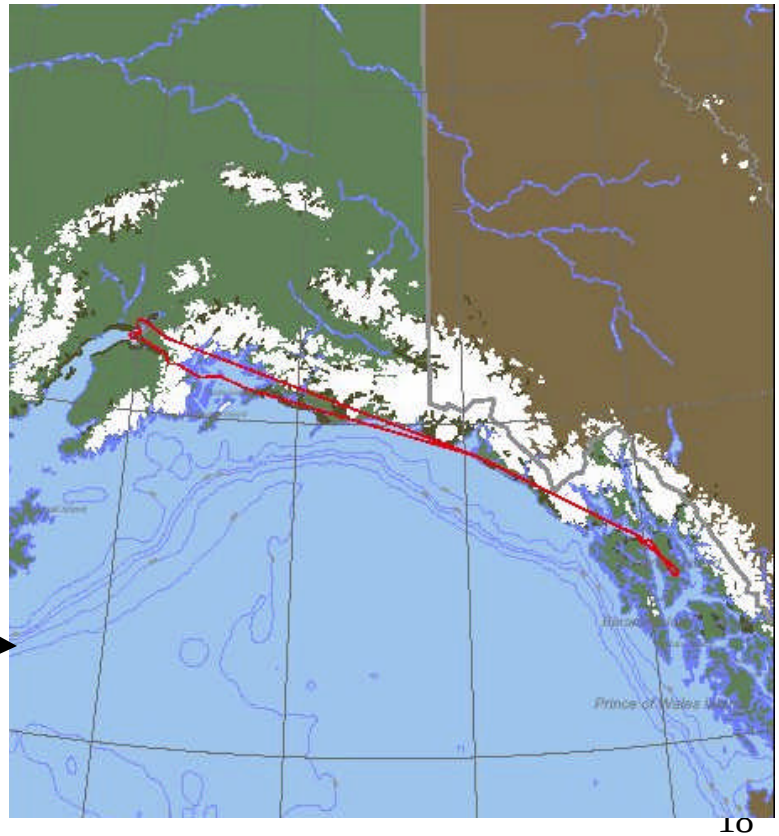


Convair Flight Paths

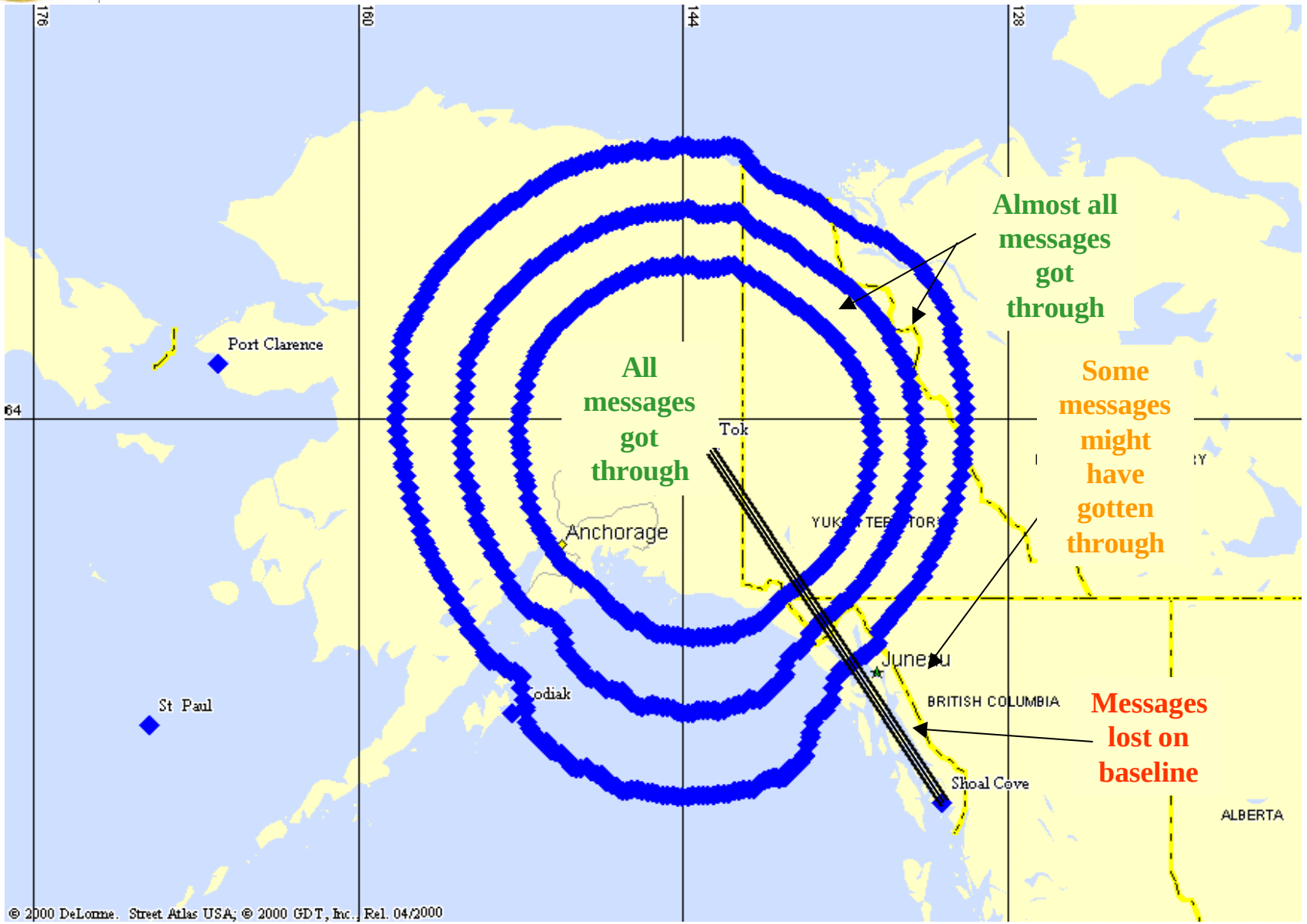


←23 August: Anchorage - Deadhorse

24 August: Anchorage - Juneau→



Actual Tok Coverage/Performance



Where are we now?

- The Loran Evaluation Program is at Milestone/Critical Decision Point II:
  - Issues have been identified
  - Alternative strategies and mitigations have been identified
  - Proof-of-concept demonstrations have been conducted to assess capability of major proposed strategies
  - Integrity Panel determining capability of ensuring required level of protection
  - Studies underway to develop improves ASF values/ASF algorithm to significantly improve Loran accuracy
  - Studies underway to determine best means of broadcasting WAAS/SBAS signal via Loran and whether real requirement exists
  - Efforts underway to integrate GPS/WAAS/Loran receivers and antennas into a signal next generation navigation receiver.

Next Generation NAV Receiver

WAAS'
$WAAS_{GEO}$ (W_G)
or
$WAAS_{LDC}$ (W_L)

GPS'
L1 or L2 or L5

LAAS

Loran'
All-in-View
H-Field Antenna
(LNAV)

Inputs
Baro Altimeter
(VNAV)

Other
TBD
(e.g., Low Cost Gyro)

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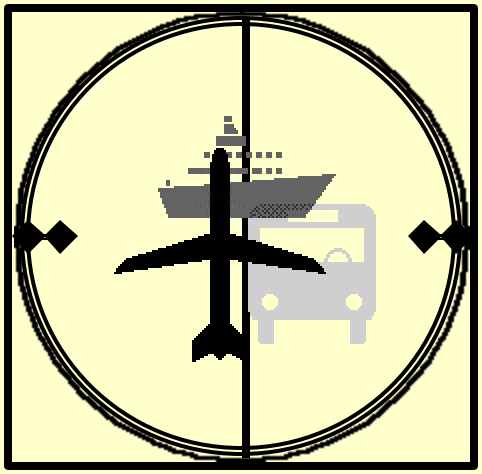

Inputs
Baro Altimeter
(VNAV)

LAAS/DGPS

Other
TBD
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